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(54) WEIGHT COMPENSATION DEVICE

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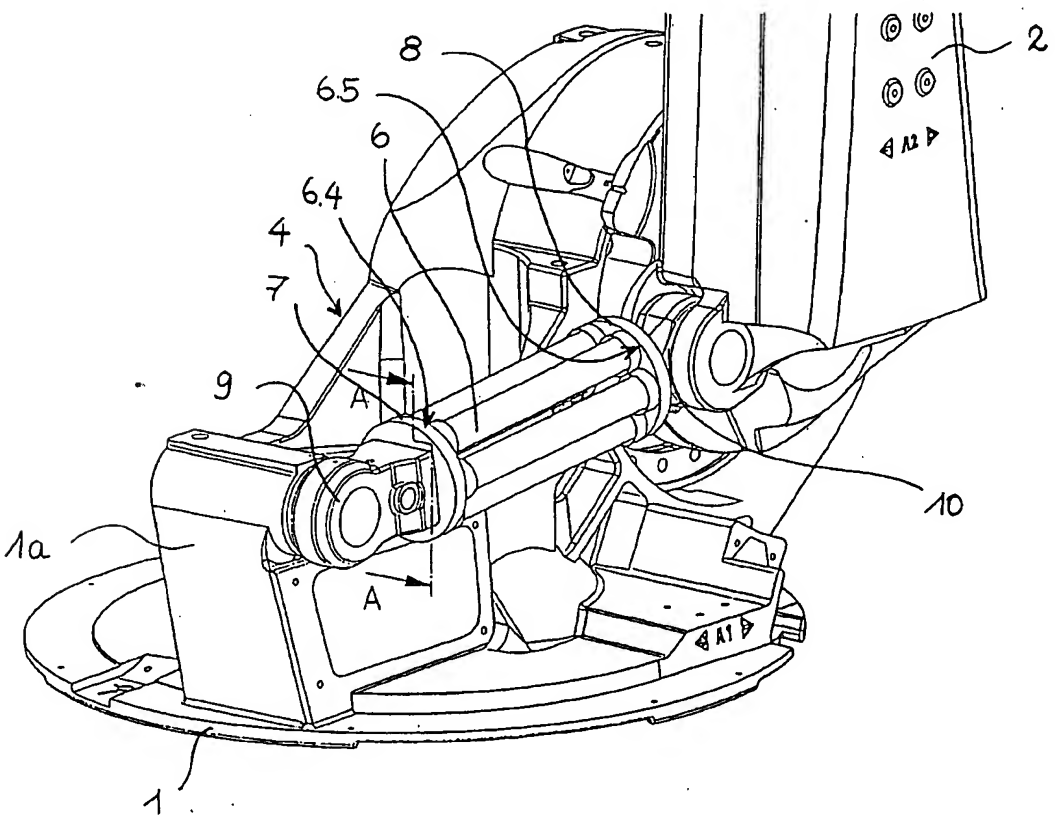
(57) ABSTRACT

A robot is provided with a robot weight compensation device having at least one hose element including an internally pressurized gas-tight inner hose portion cooperating with a high tensile strength outer portion. The high tensile strength outer portion includes non-elongatable fibers oriented relative to an axis of the at least one hose element by an angle not equal to 0° and 90°. An outer flexible protective jacket covers the fibers. A first fixing element is fixed to a first end of the hose element. The fixing element is connected to a first part of the robot. A second fixing element is fixed to a second end of the hose element. The second fixing element is articulated to a second part of the robot being movable relatively to the first robot element.



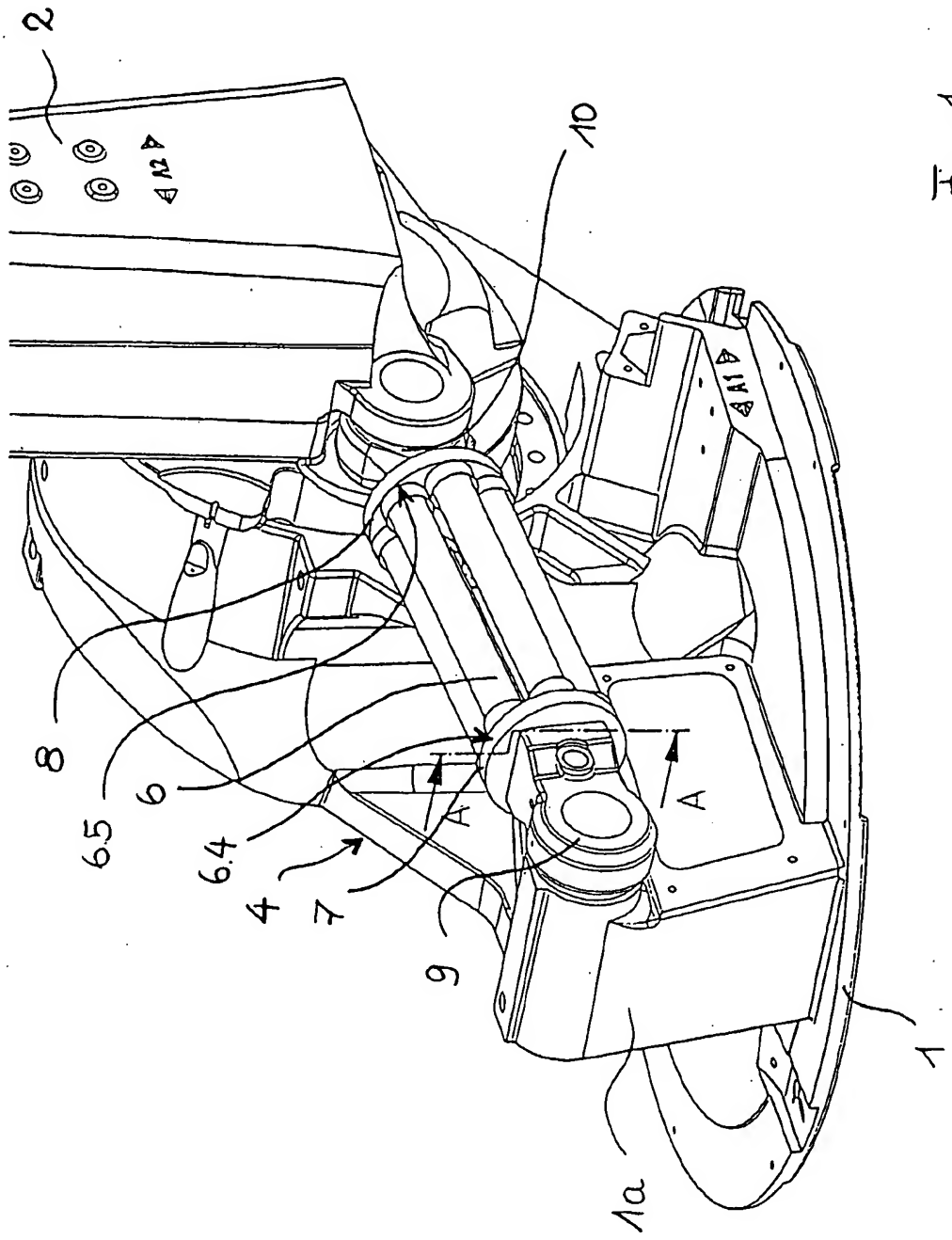


Fig. 1

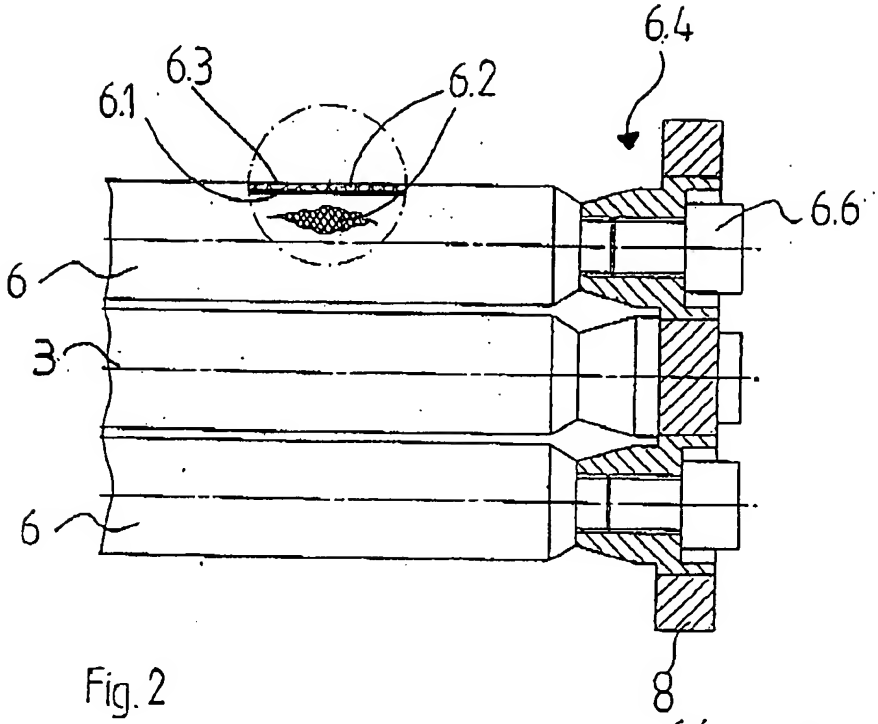


Fig. 2

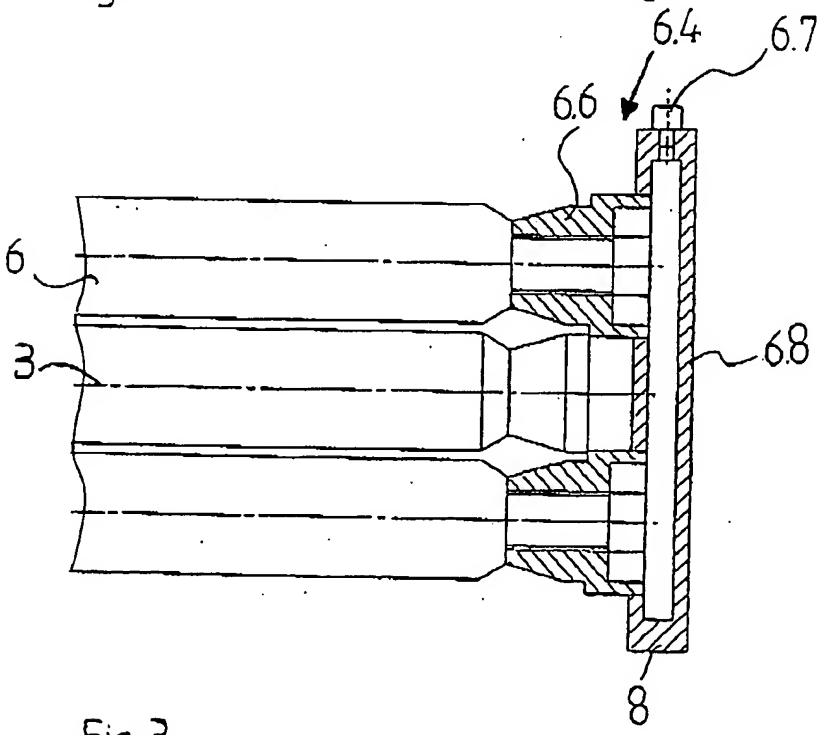


Fig. 3

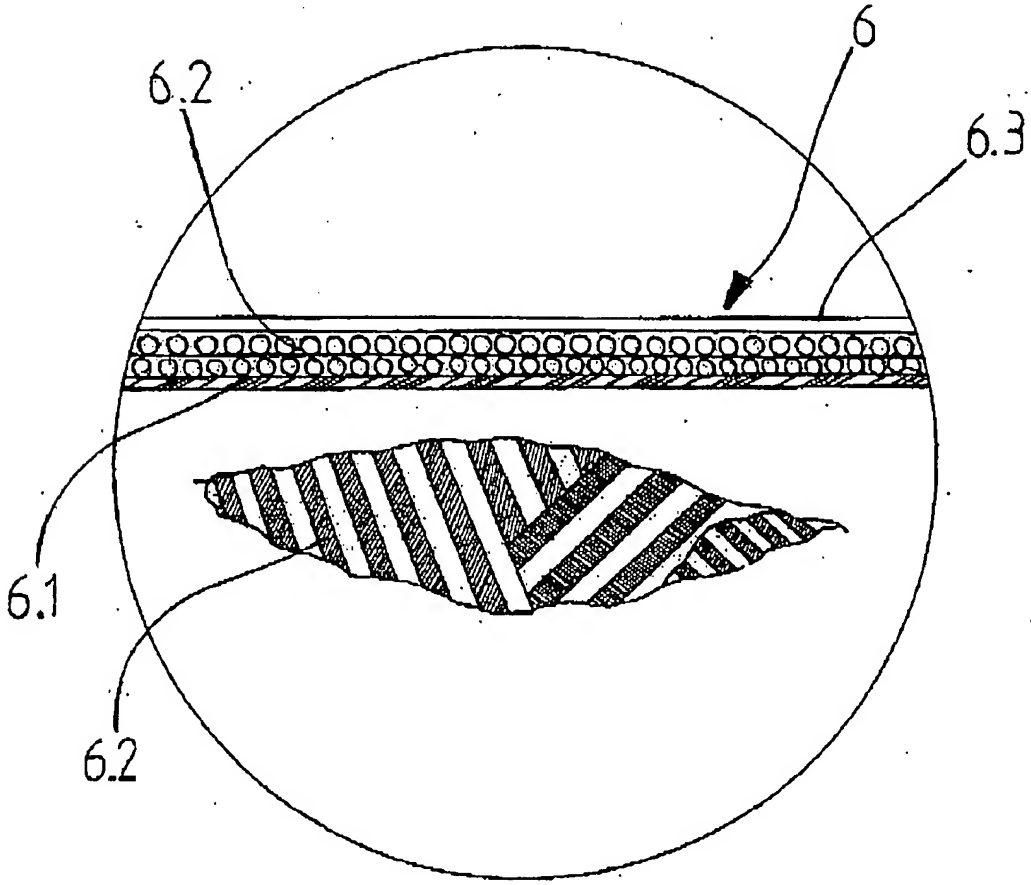


Fig. 4

WEIGHT COMPENSATION DEVICE

FIELD OF THE INVENTION

[0001] The invention relates to, a weight compensation device on a robot.

BACKGROUND OF THE INVENTION

[0002] Weight compensation devices are provided on a robot, so that the motors for the individual elements only carry out the movement work and only have to compensate to a limited extent or not at all forces and torques caused by gravitation. This more particularly applies to the rocker of a robot and its movement about the horizontal A2 axis relative to the robot carrousel and base.

[0003] Weight compensation devices have been provided with or proposed to have counterweights, mechanical springs, fluid springs in the form of pneumatic and hydraulic cylinders with pistons movable axially therein, magnetic systems, as well as lever and cable systems.

[0004] Each of the known weight compensation devices suffers from disadvantages. Thus, counterweights require a large amount of space and also increase the mass and inertia of the overall robot. Mechanical springs are relatively large if they are to apply the necessary forces and consequently have a considerable size. Fluid springs are not maintenance-free and may require the connection to a pressure medium, e.g. in a pressure container. Lever and cable systems are complicated and costly. Magnetic systems are also relatively large.

[0005] The problem of the invention is to provide a weight compensation device which both avoids the aforementioned disadvantages and requires little space and has a low weight and more particularly ensures a high flexibility in use.

SUMMARY OF THE INVENTION

[0006] According to the invention the set problem is solved by a weight compensation device on a robot by at least one tension-proof, internally pressurized hose element fixed by fixing elements and where in particular a plurality of parallel tension-proof, pressurized hose elements fixed by their ends to common fixing elements are provided.

[0007] Apart from a limited space requirement due to the slender construction provided by the invention the device has a limited weight and is also maintenance-free. It is also substantially free from wear. As a result of the tight construction of the hose elements it can also be used in clean rooms. It is also easy to manufacture and inexpensive. Moreover no lubricants are required. In the device according to the invention high flexibility results from the fact that the length can easily be chosen as a function of the intended use and the filling pressure can be easily adapted according to the intended use. As a result of the slender construction it is also possible to incorporate the device according to the invention into a rocker or arm of a robot, i.e. it can be incorporated into its carrying elements, such as walls.

[0008] The hose elements provided according to the invention can have numerous different constructions. According to a preferred development the hose elements have a flexible, gas-tight inner hose and a substantially non-extensible, substantially non-elongatable or non stretchable (or with high tensile strength hereinafter referred to as tension-proof) fibers surrounding it and the tension-proof fibers are in particular oriented under a finite angle unequal to 0° with respect to the hose element axis. Advantageously a fibrous structure is provided in which the individual fibers cross one another, so that they have a rhombic arrangement. Although not absolutely necessary, according to a preferred development of the invention in addition to the gas-tight inner hose surrounded by the fibrous structure, there is an outer, flexible jacket surrounding both the fibrous structure and the gas-tight inner hose so as to protect them against action from the outside.

[0009] Whilst there are also numerous arrangement possibilities for the hose elements in the device according to the invention, whereby the hose elements can e.g., be tightly juxtaposed as a group, according to an extremely preferred development the hose elements coaxially surround a central axis common thereto. According to a further development the fixing elements have plates with which the hose elements are connected in tension-proof, but detachable manner. The fixing elements in particular have eyelet attachments for fixing to parts of a robot. As a result of such fixing elements the device according to the invention can be easily fixed to parts of a robot and can in particular subsequently be detached therefrom. According to a highly preferred development of the invention one eyelet attachment is connected to the carrousel of a robot and the other eyelet attachment is articulated to a robot rocker eccentrically to its A2 axis.

[0010] The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its uses, reference is made to the accompanying drawings and descriptive matter in which preferred embodiments of the invention are illustrated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] In the drawings:

[0012] **FIG. 1** is a carrousel and rocker of a robot together with a device according to the invention;

[0013] **FIG. 2** is a partial sectional view of the coupling of several hose elements in a hose group corresponding to a section A-A of **FIG. 1** viewing in accordance with arrows A, A;

[0014] **FIG. 3** is a partial sectional view of another variant of the coupling of several hose elements in a hose group corresponding to a section A-A of **FIG. 1** viewing in accordance with arrows A, A; and

[0015] **FIG. 4** is a sectional view of detail C of **FIG. 2**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] Referring to the drawings in particular, **FIG. 1** shows the rotary table or carrousel **1** of a robot. Such a carrousel **1** is placed on a not shown robot base and is rotatable relative thereto about the vertical A1 axis. The rocker **2** is articulated to a robot carrousel **1** and is pivotable about the horizontal A2 axis of the robot at the lower end thereof. A motor is provided for pivoting the rocker **2**. To ensure that the motor only has to carry out the pivoting work

during the pivoting of the rocker **2** and does not have to completely compensate the forces or torques caused by gravitation, a weight compensation devices **4** is regularly provided for a robot between the carrousel **1** and the rocker **2**, being articulated thereto eccentrically to the A2 axis.

[0017] The weight compensation devices **4** has, in the embodiment shown, a device with a plurality of parallel hose elements **6**, which are preferably, as in the embodiment shown, arranged coaxially to an axis B surrounding the same. The ends of the hose elements **6** are fixed to transmit tensile forces to the connection plates **7**, **8**, which are in turn connected in one piece or firmly to the eyelet attachments **9**, **10**. The eyelet attachment **9** is firmly articulated to the carrousel **1** or a constructional element **1***a* thereof. The eyelet attachment **10** is articulated to the rocker **2** and, as stated, eccentric to the A2 axis.

[0018] The hose elements **6** have a gas-tight inner hose **6.1**, which is surrounded by a rhombic pattern of tension-proof or non elongatable (i.e., a part that can absorb tensile forces applied to its to ends and can offer a resistance to these pulling forces) fibers **6.2**, which in the embodiment shown is in turn enclosed by a protective jacket **6.3**. At their ends the hose parts including gas-tight inner hose **6.1** and fibers **6.2** are connected to connecting element **6.4** and opposite to connecting element **6.5**. Fibers **6.2** are connected to parts **6.4** and **6.5** in a tension-proof manner. One of the connecting elements **6.5** is completely closed. In the case of the other connecting element **6.4**, there is a connection **6.6** for filling the hose element **6**. The connection **6.6** can consequently be screwed on using corresponding screw thread pins to the connection plates **7**, **8**. As a result there is a detachable fixing, so that the hose elements **6** can be released or detached from the connecting elements **7**, **8** again, e.g. for pressure monitoring or refilling. In the construction according to **FIG. 2** the hose elements **6** can in each case be individually filled and optionally also with a different pressure. An advantage is that in the case of the failure of one hose the system can still function. However effort and expenditure are higher for individual filling. In the construction of **FIG. 3** a common filling takes place via a connector **6.8**, a common inlet **6.7** and the connection **6.6**.

[0019] The hose elements **6.1**, **6.2** and **6.3** are under an internal pressure and for this purpose filled with a gas. As a result of the overpressure in the interior of the hose elements they widen radially and become shorter. If a tension is exerted on hose elements **6**, if e.g. the rocker is moved out of the vertical position shown in **FIG. 1** into a position inclined to a differing extent to the horizontal, there is a reduction to the diameter of the central area of the hose element **6**. The invention gives rise to low-maintenance and also low-wear weight compensation devices, which have limited space requirements and low weight in the case of high flexibility with respect to the possible uses, because the filling pressure and length of the hose elements can be differently adjusted.

[0020] While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A robot weight compensation device, comprising:

at least one internally pressurized gas-tight hose element capable to compensate tension exerted to its ends, the gas-tight hose element built up by an inner gastight hose;

a fiber covering said hose element, said fiber covering including non-elongatable fibers oriented relative to an axis of the at least one hose element by an angle not equal to 0° and 90°;

an outer flexible protective jacket covering the fiber covering; and

fixing elements, the hose element and/or fiber covering being fixed by the fixing elements to different parts of a robot, the different parts being movable with regard to one another.

2. A device according to claim 1, further comprising additional substantially non-elongatable pressurized hose elements fixed by the ends to said fixing elements at each end.

3. A device according to claim 1, wherein said hose element is a flexible gas-tight inner hose and said fibers are non-elongatable fibers surrounding said flexible gas-tight inner hose.

4. A device according to claim 3, wherein said non-elongatable fibers are oriented relative to an axis of the at least one hose element by a finite angle not equal to 0°.

5. A device according to claim 3, wherein the fibers are arranged in a rhombic manner.

6. A device according to claim 2, wherein the hose elements coaxially surround a central axis common thereto.

7. A device according to claim 1, wherein the fixing elements have plates with which the at least one hose element is connected in a detachable manner.

8. A device according to claim 7, wherein the fixing elements have eyelet attachments for fixing to parts of a robot.

9. A device according to claim 8, wherein one eyelet attachment is connected to a robot carrousel and the other eyelet attachment is articulated to a rocker of a robot eccentric to a rocker axis of the robot.

10. A robot weight compensation device, comprising:

at least one internally pressurized gas-tight hose element capable to compensate tension exerted to its ends, the gas-tight hose element built up by an inner gastight hose;

a fiber covering said hose element, said fiber covering including non-elongatable fibers oriented relative to an axis of the at least one hose element by an angle not equal to 0° and 90°;

an outer flexible protective jacket covering the fiber covering; and

a first fixing element fixed to respective first ends of said gas-tight hose element, fiber covering and outer flexible protective jacket; and

a second fixing element fixed to respective second ends of said gas-tight hose element, fiber covering and outer flexible protective jacket.

11. A device according to claim 10, wherein said gas-tight hose element is a flexible gas-tight inner hose and said fiber covering surrounds said flexible gas-tight inner hose.

12. A device according to claim 11, wherein the fibers are oriented with respect to an axis of the hose element by a finite angle not equal to 0°.

13. A device according to claim 11, wherein the fibers are arranged in a rhombic manner.

14. A device according to claim 10, wherein the gas-tight hose element, fiber covering and outer flexible protective jacket coaxially surround a central axis common thereto.

15. A device according to claim 10, wherein the fixing elements have plates with which the fiber covering is fixed in a tension-proof, but detachable manner.

16. A device according to claim 10, wherein the fixing elements have eyelet attachments for fixing to parts of a robot.

17. A device according to claim 16, wherein one eyelet attachment is connected to a robot carrousel and the other eyelet attachment is articulated to a rocker of a robot eccentric to a rocker axis of the robot.

18. A robot weight compensation device, comprising:

a hose element with an internally pressurized gas tight inner hose portion and a high tensile strength outer portion comprising non-elongatable fibers oriented relative to an axis of the inner hose portion element by an angle not equal to 0° and 90°;

an outer extensible flexible protective jacket covering said fibers;

a first fixing element fixed to a first end of said hose element, said first fixing element being connected to a first part of a robot; and

a second fixing element fixed to a second end of said hose element, said second fixing element being articulated to a second part of the robot.

19. A robot weight compensation device according to claim 18, wherein said first part of the robot is a robot carrousel and the second part of the robot is a rocker of a robot eccentric to a rocker axis of the robot.

20. A robot having a robot weight compensation device comprising: at least one hose element including an internally pressurized gas-tight inner hose portion cooperating with a high tensile strength outer portion, the latter comprising non-elongatable fibers oriented relative to an axis of the at least one hose element by an angle not equal to 0° and 90°; an outer flexible protective jacket covering the fibers; a first fixing element fixed to a first end of the hose element, said fixing element being connected to a first part of the robot and a second fixing element fixed to a second end of said hose element, said second fixing element being articulated to a second part of the robot being movable relatively to the first robot element.

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